A Petrographic Analysis of Two Sand Bodies of the Lower Conemaugh Series as Exposed Near Toronto, Ohio

Senior Thesis

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by

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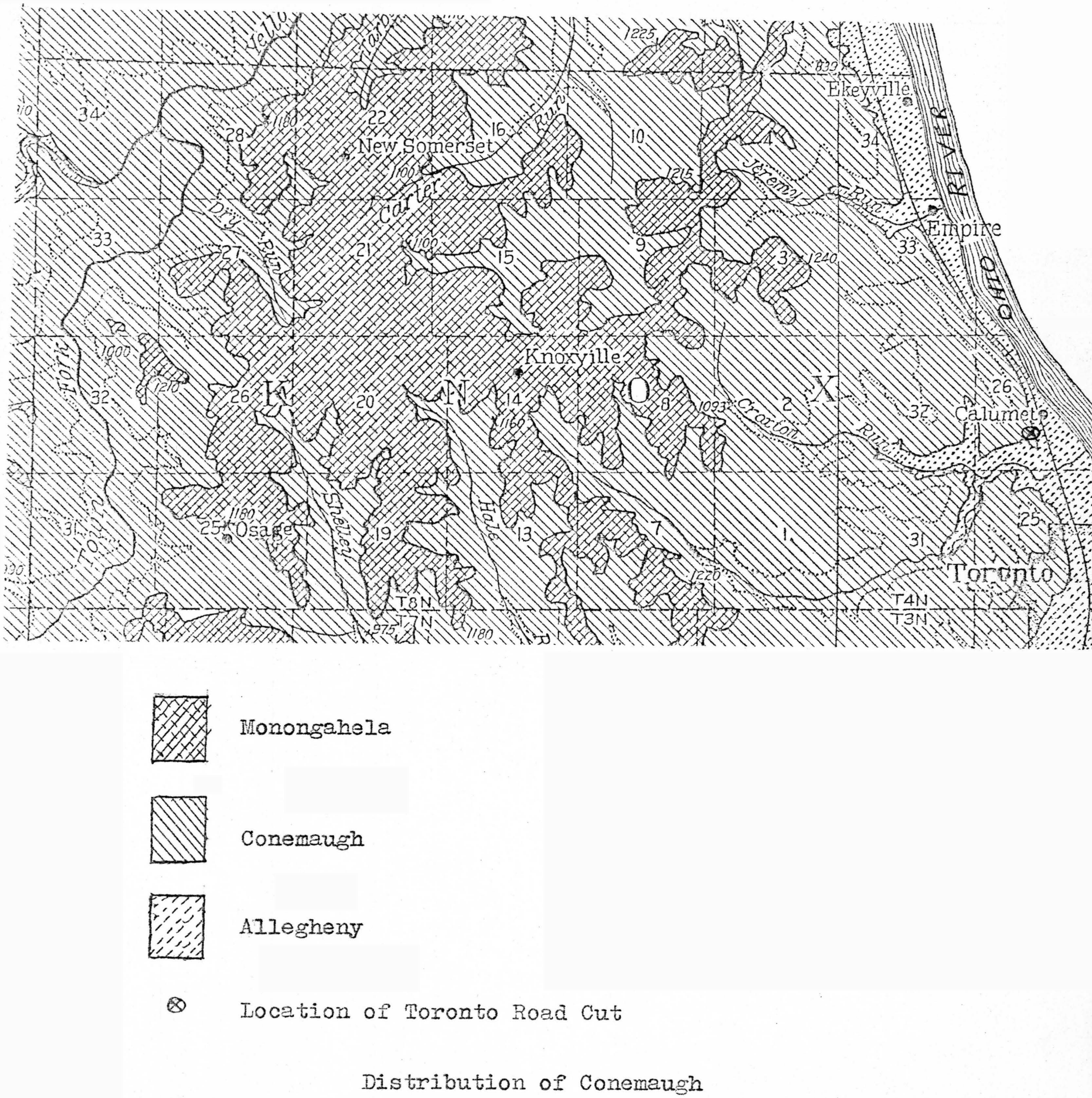
INTRODUCTION

During February and March of 1974, I collected samples from two sand bodies of the lower Conemaugh "Series" as exposed in the Toronto Road Cut, which is situated along the west side of the Ohio River directly across from New Cumberland, West Virginia. The exposure is approximately 1 1/4 miles long and trends north along state highway 7 beginning 1/4 mile north of the city of Toronto, Ohio, within Knox Township section 26, Wierton 7 1/2 Quadrangle.

From the samples collected thin sections were made and studied. X-Ray analysis were also performed on some of the samples. The thin section descriptions, hand specimen descriptions, and X-ray data will be reproduced in this paper, and from this data an interpretation of the environment of deposition and the source rock will be made.

Figure 1



Distribution of Conemaugh
in Knox Township

HISTORICAL SUMMARY

The rocks exposed near Totonto, Ohio, are Pennsylvanian in age. On the basis of lithology this system has been subdivided into smaller parts known as series. The major classification in descending order is as follows:

Pennsylvanian system
- Monongahela "series"
- Conemaugh "series"
- Allegheny "series"
- Pottsville "series"

In this report the main interest is centered on the Conemaugh series. These strata have been described under various names by workers in different parts of the Appalachian basin. The most striking feature of these rocks, as described by the early geologists of the First Geological Survey of Pennsylvania, is the absence of the thick and widely extended coal beds, such as characterize the underlying Allegheny and the overlying Monongahela "series", hence the name "Lower Barren Coal Measure" was adopted. At this time the lower boundary was placed at the top of the Mahoning Sandstone, and the upper boundary at the bottom of the Pittsburg Coal. Because of the vague and indefinite surface of the top of the Mahoning Sandstone the lower boundary was later placed at the top of the Upper Freeport Coal.

About 1875 Franklin Platt applied the name Conemaugh to these rocks, because of their good exposure along the Conemaugh River in western Pennsylvania. Later in 1891, I.C. White proposed the name "Elk River Series" for the exposures along the Elk River above Charleston, West Virginia. The name that Platt proposed has since become the term generally used, hence these rocks have become known as the Conemaugh "series".

Recent work on the Conemaugh is scarce, but much work has been done on the underlying Allegheny rocks. These reports by Ferm and Williams (1960 1964), Ferm (1962,1970), Webb (1963), Cavaroc and Ferm (1968, 1969) are concerned with the general nature of the Allegheny dealing with the environment of deposition of the total rock sequence.

STATIGRAPHY

The distribution of the Conemaugh in Knox Township is shown on Figure 1. It as a whole is composed of frequently recurring beds of all common varieties of sedimentary rocks, such as sandstone, shale, clay, coal, and limestone. The following stratigraphic section is a generalized section of the lower Conemaugh as found in Jefferson County, Ohio, near Toronto.

STRATIGRAPHIC SECTION

PENNSYLVANIAN	Upper	Conemaugh	Buffalo Sandstone Shale, arenaceous Brush Creek Limestone Brush Creek Coal Clay, limestone nodules Shale, arenaceous Mason Shale, with shaly coal Clay, gray to pink mottled Shale, arenaceous Upper Mahoning Sandstone Mahoning Coal Thornton Clay Shale, arenaceous Lower Mahoning Sandstone
	Lower	Allegheny	Upper Freeport Coal or No. 7 Upper Freeport Limestone Bolivar Clay Upper Freeport Sandstone

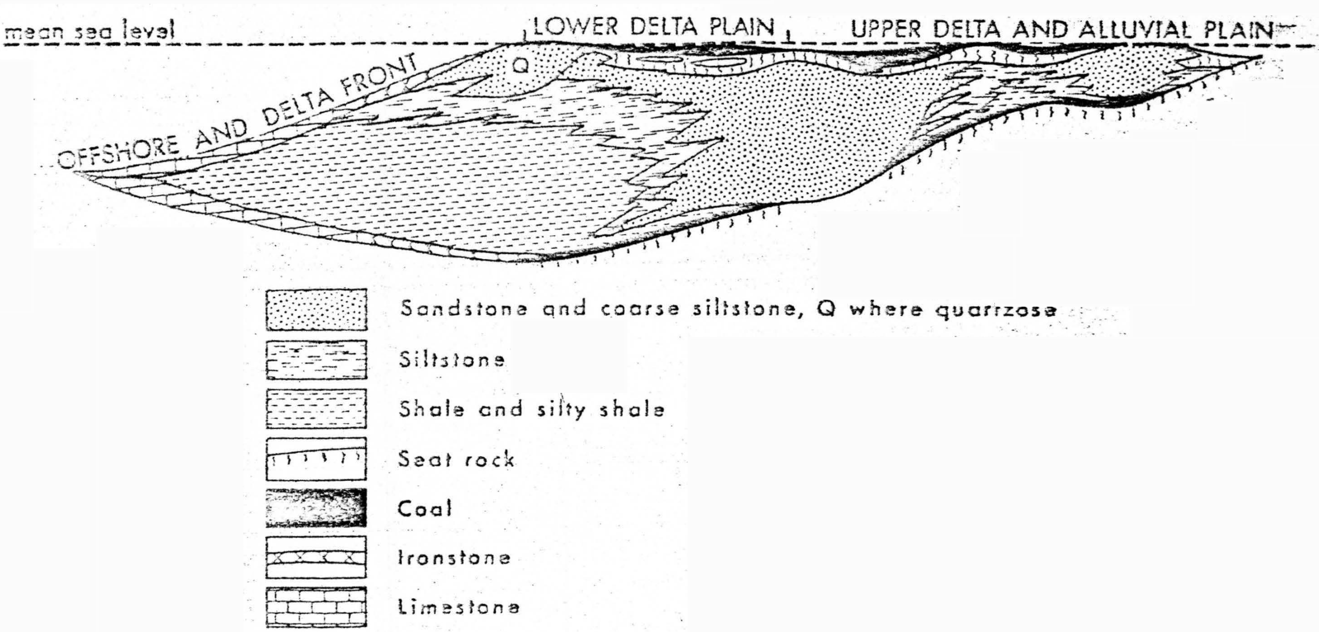
STRATIGRAPHIC CONCEPT - THE CYCLOTHEM

One of the more recent concepts applied to Carboniferous stratigraphic problems is that of depositional models which state that individual rock types occur in one or more specific arrangements with respect to one another and that these patterns can be related to certain genetic events. The model most generally accepted is that of the cyclothem, which was devised ine the Illinois Basin and adapted to situations in other areas. In basic form it consists of a vertical sequence which from top to bottom, is made of sandstone with a disconformable base, siltstone, underclay with or without fresh water limestone, coal, dark shale, limestone with marine or brackish fossils, gray shale and siltstone which is truncated at the top by a disconformity separating it from the next overlying cyclothem. Strata from the coal downward is nonmarine, whereas the strata above is primarily marine, thus producing a regressive- transgressive relationship as the major genetic mechanism.

One of the major difficulties in this theory is that in any examination of Pennsylvanian outcrops, one or more of the elements of the sequence may be missing and other rock types may be found. In fact most Pennsylvanian cycles are strongly regressive with many of the marine members missing.

The genetic connection between this model and the pattern of recent deltaic sediments should be noted. Comparisons between sequences and lateral changes of the Pennsylvanian model (Figure 2) and those known from recent Mississippi River deposits shows such close similarity that some of the termonology indicating specific recent environments is also included on Figure 2.

Figure 2



A generalized Pennsylvanian lithogenetic model showing inferred environments in a deltaic milieu

PROCEDURE

The two sand bodies under investigation were sapmled horizontally at twenty foot intervals, and vertically at intervals of five to seven feet. Samples were also collected from the strata above and below the sand body, and at any sharp change in lithology within the sand body itself.

Thin sections were made from representative samples. The properties described in this report are mineral composition, grain size, sorting, color, fossil content, primary structures, grain orientation, and sphericity and angularity. The mineral composition and percentage of varietal types were determined by making a 250 grain point count on each slide. Mean size and sorting was also determined by the point count technique. The clay mineral content was determined by X-ray diffraction analysis. X-ray work was conducted on the General Electric X-Ray Diffractor using CuK alpha, Ni filtered radiation. The samples were crushed and then mounted on glass slides with acetone and Duco cement. The slides were placed in the defractor and the angle 2θ was measured from 5 to 35 degrees. The data was interpreted and the mineral composition determined. The relative abundance of the minerals was determined from the equation

$$\%X = \frac{HX}{HX+HY+HZ}$$

where H= height of peak in inches above the normal. The results are found in Table 3 of the appendix.

A detailed petrographic report form as found in <u>Sand and Sandstone</u>; Pettijohn, Potter, and Siever; 1972 p. 589 was followed to facilitate petrographic analysis. This form emphasizes the comprehensive nature of a complete description.

PETROGRAPHIC ANALYSIS

Field Relations of the Sand Bodies

Sand body A is approximately 60-70 feet thick. A sharp erosional base separates it from the shale below. The basal unit of the body is a conglomerite, with locally derived pebbles and siderite clay concretions. Cross bedding is characteristic throughout, and other minor scour surfaces with some siderite nodules are also present. The sand grades upward into interbedded siltstone and clay. Plant fossils, mostly carbon films of stems and twigs are found all through the sand body.

Sand body B is approximately 60 feet thick. It is underlain by a sandy siltstone and a dark shale overlies it. Fossils are sparse in this sandstone. There is no basal conglomerite unit as was found in sand A, and it is uniform in grain size throughout as opposed to Sand A which fines upward.

Hand Specimen Description

The sandstone of body A is brown to yellow brown in the outcrop. The unweathered surfaces are a light gray. The sand fines vertically from a medium sand to a very fine sand size on top. Muscovite is prominent in most samples as well as shaly particles. These two elements together form planes of parting in some samples. The sandstone seems well sorted and the grains appear rounded.

Sandstone B is light gray to white in color. The grains remain uniform in size throughout. They are medium size grains. Muscovite and argillaceous particles are common and form planes of parting as in sand A. The sand is well sorted and appears well rounded. Weathered samples are darker gray with a brownish tinge in color.

Thin Section Description

Both sands are well sorted lithic arenites. The sand of Body A consists of about 58% subrounded mono and polycrystalline Quartz, 8% Feldspar, 15% Rock Fragments, 9% Clay and highly squeezed Rock Fragments, and 5% Silica and Limonite cement. Sand Body B is a well sorted and well rounded lithic arenite. It consists of about 65% mono and polycrystalline Quartz, 7% Feldspar, 13% Rock Fragments, 5% Clay or highly squeezed Rock Fragments, 2% Dolomite and 7% silica cement. From mapping and outcrop studies done by Ferm and Cavaroc (1969) and Ferm (1962) on the sands in this area, the strata seems to represent part of the upper deltaic plain sequence, with the material being derived from the Appalachian mobile belt.

Both sands are supported by a Quartz-Feldspar-Rock Fragment framework. Compaction of the rock fragments has squeezed them into a clay matrix which fills in the pores. Grain contacts are numerous being planar and concave-convex types.

The grains tend to be equant and hence orientation is only noticed by studies of the muscovite flakes, which tend to be oriented parallel to the bedding.

The sandstones are cemented with a mixture of silica, liionite, clay matrix, and a small amount of dolomite. Sand Body A tends to have more limonite and clay matrix. Sand Body B has more dolomite. With the mixture of chemical cements and clay matrix the porosity of the sand is reduced greatly.

The grains of Sand A are generally subrounded with larger grains tending to be more rounded than smaller grains. The sand grains of Body B are more rounded than those of Sand A. The feldspar grains tend to be more angular than any other component.

The sands are both well sorted. (If clay matrix is not counted as detrital, but as decomposed rock fragments) Sand A shows a gradually upward fining sequence. The size ranges from a course fraction of 1Ø to the fine size of 4Ø. Sand B is uniform in size and is approximately 2Ø.

Giving sands a specific textural name depends greatly on the amount of clay matrix present. If the clay in these sands is counted as a decomposition product of the rock fragments and feldspar, then the sands, since they are well sorted and subrounded, would be considered as mature.

Nearly all the mineral constituents of these sands can be considered members of two large groups — (1) silica (mostly quartz) and (2) mica-clay minerals and mineral aggregates. Other constituents - feldspar, carbonates, etc.- make up less than 10% of the entire rock.

Quartz is separated into mono and polycrystalline, chert, and secondary quartz. For sand Body A greater than 90% of the quartz is of the mono and polycrystalline type. Composite grains showing crenulated boundaries (plate 1) are probably of metamorphic origin. Many of the larger grains show strong strain shadows. The smaller particles are without distinctive characteristics. Detrital chert grains occur in very small quantities. Silica overgrowths are also present in small amounts. The quartz of Sand B consists of about the same percentages of quartz types but has a somewhat smaller percentage of polycrystalline grains.

Rock fragments are mostly argillaceous being both sedimentary, probably ripped up from underlying shale, and metamorphic. Many are deformed and corroded on the edges. (plate 2) The sedimentary fragments are mostly shale and the metamorphics are phyllites with some schists. Many of the rock fragments have been decomposed and are forming the clay matrix which fills in the pore space.

The most common micas are muscovite and chlorite with small amounts of biotite. The flakes are deformed around the quartz grains and are abundant in parting planes. (plate 3)

The mica is oriented parallel to bedding. In Sand A muscovite is more abundant than in Sand B. The chlorite content is slightly higher in Sand B than in Sand A.

Minor constituents include feldspar, carbonates, and accessories. Feldspars are represented by badly sericitized and kaolinized grains of orthoclase, microcline, and albite-oligoclase. Siderite is the most abundant carbonate and is the principle constituent of the clay-ironstone nodules found in the basal conglomerite of Sand A. Small amounts of dolomite are also present, Sand B having a higher percentage than Sand A. The opaque minerals are mainly leucoxene, limonite, and pyrite.

The clay minerals were analysized by X-ray diffraction and found to be mostly illite, kaolinite, and chlorite. In general Sand B contains more illite and chlorite than Sand A.

Tables one through three in the appendix show the results of the point counts on the thin sections, and the results of the X-ray analysis.

INTERPRETATION AND CONCLUSIONS

The material of these sandstones seems to have been derived from a sedimentary and metamorphic source. Abundant metamorphic rock fragments such as phyllites and schists, along with quartz grains with strong undulose extinction and crenulated boundaries suggests a source of metamorphic rocks. The small percentage of feldspar reflects an absence of any large igneous source. The relative abundance of weak particles such as micaceous rock fragments indicates that transport was neither long nor vigorous. The material was probably delivered from the east by a large fluvial system.

The characteristics of Sand A suggest a dominantly alluvial origin. The erosional scour and course conglomerite with the fining upward sequence is characeristic of an alluvial channel sand. The plant remains and crossbedding also suggest an alluvial channel.

Sand Body B has no basal scour and the size of the grains remains uniform. There is no basal conglomerite as in Sand A. No fossil remains were found in the sand. Because of the lack of a basal scour, lag deposit, and fossil remains, and also the lack of any variance in grain size, it is highly improbable that sand B is an alluvial channel sand.

As stated by Ferm et.al.,1969, this area during the Pennsylvanian was an area of transition between the alluvial and deltaic sections of a coastal plain-deltaic complex. The two most common sands found in this transition zone are alluvial sands and distributary sands. Sand Body B, because of its characteristics, is probably a distributary mouth bar.

SUMMARY

During the Upper Pennsylvanian the area to the east was being eroded and large amounts of metamorphic and sedimentary material was being carried to the west. Eastern Ohio was at this time part of the alluvial-upper deltaic section of a coastal plain-deltaic complex. The two sands A and B represent the two most common sand types in this section of the complex, respectively an alluvial channel sand and a distributary mouth bar.

APPENDIX

TABLE 1 - MODAL ANALYSIS - SAND A

sample	quartz		chert	rock frag	feldspar		mica	clay matrix	ave. size
	Mono	poly			k-spar	plag			in mm.
1VT	29.2	27.8	1	17	3.2	4.1	4.2	11.4	0.15
2VT	26.8	28.0	T	19	3.4	2.1	5.1	15.7	0.05
3VT	36	33.1	1.5	15	3.4	3.9	3.0	9.2	0.25
7VT	35	27.2	2	13.1	3.7	4.3	4.8	9.3	0.16
8VT	32.7	34.8	1.5	12.9	3.4	2.7	3.7	9.0	0.13

Results expressed in precent

T* - Trace

TABLE 2 - MODAL ANALYSIS - SAND B

sample	quartz		chert	rock frag	feldspar		mica	clay matrix	ave. size
	mono	poly			k-spar	plag			
4HT	38	26	T	15	5	3	2.5	8.9	0.25
7HT	32	25	2	18	4.7	2.4	2.0	3.9	0.2
8HT	35	30	1	13	3.5	3.5	5.0	9.8	0.2
11HT	34	28	1	12.8	4.2	3.9	3.0	10.0	0.14
12HT	37	20	1	18.4	5.1	6.5	3.0	9.0	0.25
13HT	38	28	2	13.0	4.1	2.9	1.5	4.5	0.2
14HT	39	25	2	14.0	4.4	6.0	4.2	6.0	0.18

TABLE 3 - X-RAY ANALYSIS

SAND BODY A

sample	qtz	feldspar	illite	dolomite	kaolin-chlorite
2VT	85.39	3.0	3.46	2.7	5.3
3VT	81.8	1.8	2.0	3.1	7.9
5VT	82.5	3.0	2.4	2.9	7.4
7VT	81.8	2.1	2.1	2.8	8.1
9VT	81.5	2.9	2.9	3.0	7.9

SAND BODY B

sample	qtz	feldspar	illite	dolomite	kaolin-chlorite
2HT	81.2	3.0	3.8	3.5	8.4
7HT	80.1	3.9	3.6	3.8	8.5
8HT	82.0	3.1	3.5	2.9	7.5
12HT	81.0	2.9	4.2	3.2	8.1
14HT	82.1	4.3	2.3	3.9	8.2

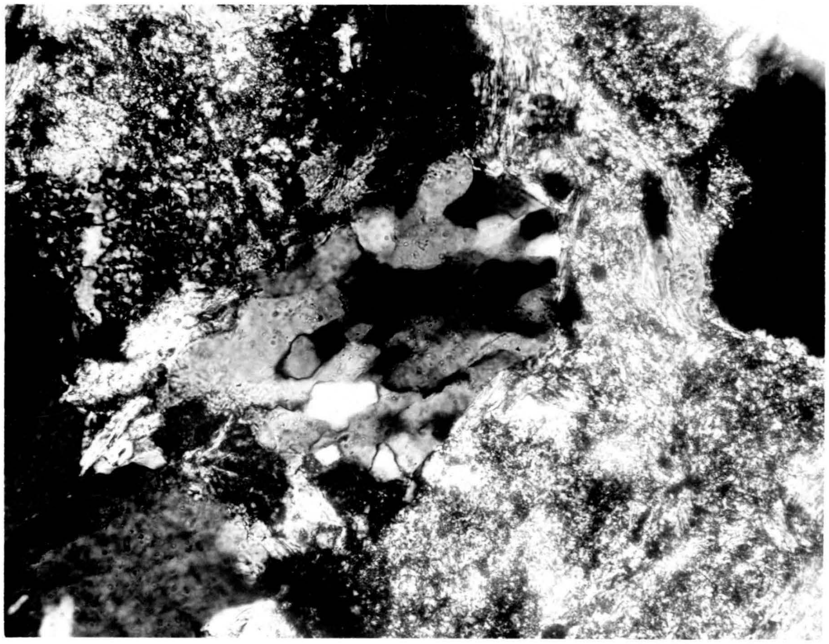


Plate 1 - Metamorphic Quartz type, Crenulated boundaries.

Plate 2 - Deformed and corroded Rock Fragments

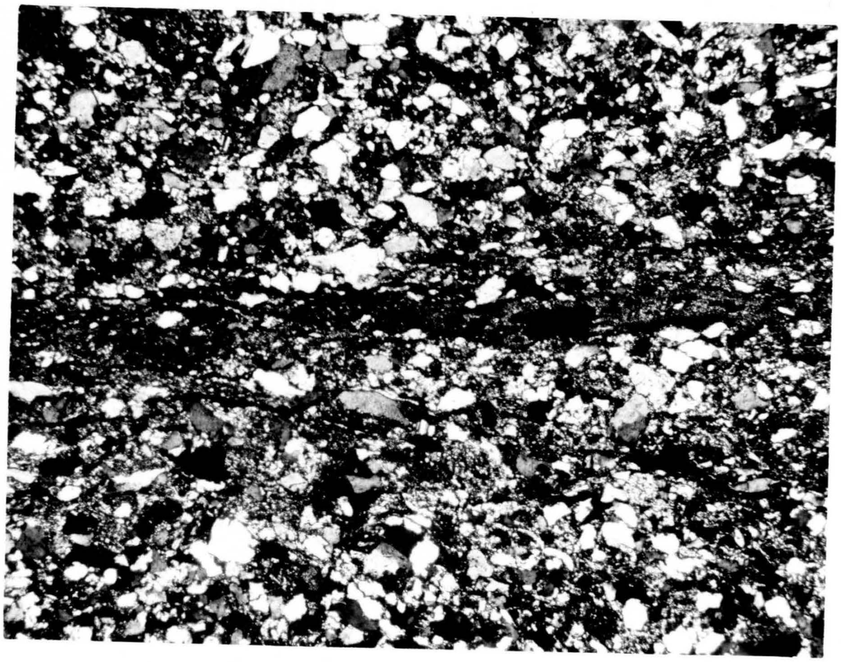


Plate 3 - Mica Flakes forming Planes of Parting

Plate 4 - Subrounded and Well Sorted Grains

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